

BMJ Open Perioperative hypothermia prevention: development of simple principles and practice recommendations using a multidisciplinary consensus-based approach

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To cite: Munday J, Duff J, Wood FM, *et al.* Perioperative hypothermia prevention: development of simple principles and practice recommendations using a multidisciplinary consensus-based approach. *BMJ Open* 2023;**13**:e077472. doi:10.1136/bmjopen-2023-077472

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2023-077472>).

Received 06 July 2023

Accepted 31 October 2023



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ABSTRACT

Objectives To develop a consensus on evidence-based principles and recommendations for perioperative hypothermia prevention in the Australian context.

Design This study was informed by CAN-IMPLEMENT using the ADAPTE process: (1) formation of a multidisciplinary development team; (2) systematic search process identifying existing guidance for perioperative hypothermia prevention; (3) appraisal using the AGREE II Rigor of Development domain; (4) extraction of recommendations from guidelines meeting a quality threshold using the AGREE-REX tool; (5) review of draft principles and recommendations by multidisciplinary clinicians nationally and (6) subsequent round of discussion, drafting, reflection and revision by the original panel member team.

Setting Australian perioperative departments.

Participants Registered nurses, anaesthetists, surgeons and anaesthetic allied health practitioners.

Results A total of 23 papers (12 guidelines, 6 evidence summaries, 3 standards, 1 best practice sheet and 1 evidence-based bundle) formed the evidence base. After evidence synthesis and development of draft recommendations, 219 perioperative clinicians provided feedback. Following refinement, three simple principles for perioperative hypothermia prevention were developed with supporting practice recommendations: (1) actively monitor core temperature for all patients at all times; (2) warm actively to keep body temperature above 36°C and patients comfortable and (3) minimise exposure to cold at all stages of perioperative care.

Conclusion This consensus process has generated principles and practice recommendations for hypothermia prevention that are ready for implementation with local adaptation. Further evaluation will be undertaken in a large-scale implementation trial across Australian hospitals.

INTRODUCTION

All clinicians caring for patients undergoing surgery have a responsibility to prevent perioperative hypothermia. Perioperative

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This study used a consensus-based approach using the ADAPTE process, not to develop another guideline, but to develop principles and recommendations for perioperative hypothermia prevention ready for implementation.
- ⇒ A multidisciplinary team representing nursing, anaesthesia and surgery contributed either as members of the investigatory team, panel or wider network of clinicians to evaluate the recommendations.
- ⇒ To address the complexity of perioperative hypothermia prevention, we present simple principles underpinned by practice recommendations to assist with adaptation and implementation.
- ⇒ This work represents an important conceptual stage in knowledge translation but requires further testing in an implementation trial to determine the impact on patient care and outcomes.

hypothermia, defined as a loss in core temperature to below 36°C,¹ is in most cases preventable if proactive and coordinated planning is enacted. Yet, in Australia over a quarter of patients undergoing surgery are hypothermic on arrival to post-anaesthetic care.² Specific surgical populations such as caesarean delivery have a higher prevalence.^{3,4}

Warmed patients experience less shivering,⁵ increased satisfaction⁵ and a greater sense of well-being.⁶ In contrast, evidence suggests that perioperative hypothermia increases the risk of wound infection,^{1,5,7} surgical bleeding¹ and blood transfusion,^{1,5} morbid cardiac events,^{1,8} increased recovery time and longer overall stay.⁹ Adverse outcomes associated with perioperative hypothermia cost the Australian healthcare system an estimated \$1.3 billion per annum.¹⁰

Coordinated core temperature monitoring and use of warming strategies are fundamental practices to prevent hypothermia and associated complications, underpinned by decades of evidence.¹ Nonetheless, almost one-third of Australian patients receive no temperature monitoring at all before admission to post-anaesthetic care² and many do not receive appropriate intraoperative active warming.^{11 12}

Factors contributing to low uptake of practices to prevent hypothermia are multidimensional, but low awareness of guidelines is common.^{13 14} While the challenges of improving guideline uptake are not unique to perioperative care,¹⁵ in the area of perioperative hypothermia prevention, low guideline uptake is profound and impedes coordinated care.¹⁶ There is no single nationally endorsed consensus or guideline for perioperative hypothermia prevention among professional groups in Australia. Since 2017, national professional guidance and standards have been produced by the Australian College of Perioperative Nurses (ACORN),¹⁶ the Australian and New Zealand College of Anaesthetists (ANZCA)¹⁷ and the Australian College of Perianaesthesia Nurses.¹⁸ Additionally, there are conflicting beliefs about roles and responsibilities among clinicians about who does what.¹⁴

Consensus on practice recommendations for hypothermia prevention among perioperative clinicians can be valuable to support a team-based approach and resolve contradictions between guidelines.¹⁹ Consensus statements have an impact on policy and practice in many areas of healthcare.^{20 21} Developing consensus on perioperative hypothermia prevention may provide a basis for the development of national policy and care standards that are long overdue.

Perioperative care is an example of a complex adaptive system within the larger, complex adaptive system of the hospital.²² Clinicians are challenged to provide consistent, coordinated hypothermia prevention and the integrated approach needed to implement guidelines.¹ Perioperative hypothermia prevention itself is a complex intervention. It involves many activities that should interact with each other (eg, temperature monitoring alongside warming), enacted by different teams at different times, and requiring adaptation to the context.^{23 24}

Striving to force complex systems to fit rigidly to 'detailed standardisation' can be futile because these systems are not machine-like and need adaptation and human input through judgement and expertise.²⁵ The use of what Plsek²⁵ calls 'simple rules' to guide practice enables action by providing overarching direction, but

with sufficient freedom to adapt practice based on the complexity of the system. Through a consensus process, we aimed to synthesise knowledge on perioperative hypothermia prevention, not to add to the number of guidelines, but to synthesise current guidance and generate simple principles supported with practice recommendations. Simple principles allow enough direction to guide practice, while enabling further adaptation to context.²⁶ The aim of this project was therefore to bring together clinicians to develop a multidisciplinary consensus on perioperative hypothermia prevention for adult patients. The outcome of this process was a knowledge product²⁷ ready for local adaptation by clinicians during implementation.

METHODS

We used a process of guideline adaptation proposed by the ADAPTE Collaboration²⁸ and further described by CAN-IMPLEMENT.¹⁵ The ADAPTE Collaboration provides a process of adapting guidelines that have been developed in one or more settings for use in another organisational or cultural context.^{15 28} The ADAPTE method was appropriate as our aim was to adapt existing international guidelines and those produced by different professional groups, for use in the Australian context and to develop principles for practice, rather than to develop a new guideline.²⁸ Additionally, this process allows for a participatory approach to foster ownership of guidance that is clinically relevant.^{15 28} This met our aim of facilitating multidisciplinary engagement with principles and practice recommendations for perioperative hypothermia prevention. As perioperative hypothermia prevention is a complex intervention, we aimed to generate simple principles to guide practice, with supporting practice recommendations. The assumption was that in large complex adaptive systems such as perioperative care, working with principles rather than rigid standardisation to shape practice change allows for accountability, but with greater freedom for adaptation to context.²⁵

This work is the first stage of a larger project to improve perioperative hypothermia prevention in Australian hospitals, guided by the Knowledge-to-Action framework.²⁷ This framework includes a process of Knowledge Creation, followed by an Action Cycle.²⁷ Our work to synthesise guidance to generate a knowledge tool or product (simple principles and practice recommendations) is situated within the Knowledge Creation phase. The following six-step process (see [figure 1](#)) was used.

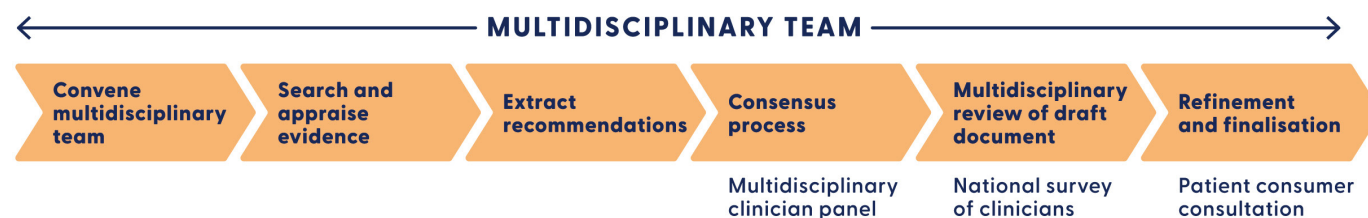


Figure 1 Consensus-based process of guideline adaptation.

Establishing a multidisciplinary development team

A multidisciplinary development team was formed, comprising six perioperative clinicians and researchers. Team members also represented a Hypothermia Special Interest Group and members of the following professional colleges: ACORN; ANZCA and Royal Australasian College of Surgeons.

Search for existing evidence

Guidance for perioperative hypothermia prevention in adults was identified through a systematic search process in the following databases: PubMed; Agency for Healthcare Research and Quality Guideline Clearinghouse; Cochrane Library and Guidelines International Network. Initial search terms (perioperat*, hypotherm*, surg*) were expanded to include relevant MeSH headings and a health librarian was consulted on the final search strategy. Websites of relevant professional organisations and clinical sites relevant to perioperative practice were also searched. A date range from 2008 until 21 July 2021 was applied, on the basis that the National Institute for Health and Clinical Excellence published the seminal guidance on perioperative hypothermia prevention in 2008.¹ No language limit was applied. Guidelines, papers reporting bundled recommendations or evidence-based

pathways were included. Papers that reported on processes to develop guidelines but did not report the actual guidelines were excluded. Additionally, papers that focused on implementation of guidelines were also ineligible. After the removal of duplicates, independent screening of titles and abstracts was conducted by two team members. Where there was disagreement, a third member was asked to adjudicate on guideline inclusion. Full texts were retrieved for papers deemed to be relevant. Online supplemental file 1 provides the complete search strategy across all databases, websites and registries. A Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart (figure 2) reports the flow of papers for inclusion at all stages.²⁹

Appraisal

Full texts were critically appraised independently by team members using Domain Three of the Appraisal of Guidelines for Research & Evaluation (AGREE) II document: Rigor of Development³⁰ and entered into REDCap. The AGREE II tool is an internationally recognised and extensively validated tool for assessing the quality and reporting of clinical practice guidelines.³⁰ The complete tool comprises 23 items within six domains and then provides an overall assessment of the guideline being

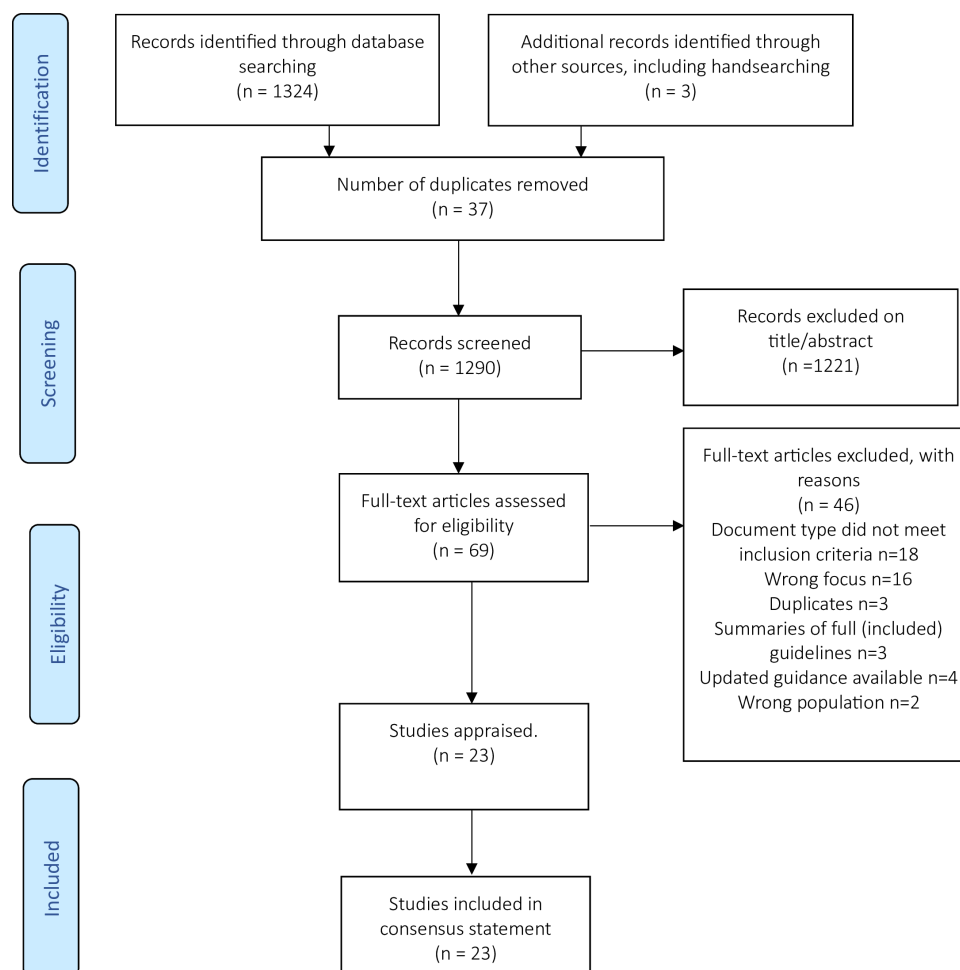


Figure 2 PRISMA flow diagram. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

reviewed.³⁰ The Rigor domain comprises eight items that focus on evidence supporting the guideline, methods for recommendation development and the guideline process for review and updating.³⁰ Items are graded using a seven-point Likert scale with responses ranging from strongly disagree to strongly agree.³⁰ Two team members reviewed and appraised each document independently, with a third reviewer adjudicating where needed. Responses were collated in REDCap and assessed for consensus on each item.

Recommendation extraction and development of draft guidance

Following critical appraisal, recommendations were extracted from papers meeting a quality threshold and then mapped, where possible, to perioperative phases of care (preoperative, intraoperative and postoperative). The draft items were then individually assessed for clinical applicability, alignment to local values and preferences, and implementability using the AGREE-REX: Recommendation EXcellence tool.³¹ The AGREE-REX tool comprises nine items within three domains that specifically examine the clinical credibility and implementability of the document being reviewed.³¹ Each recommendation was rated for quality and suitability for use within each quality domain, on a 1–7 scale (where 1=strongly disagree, 7=strongly agree). For inclusion, items were required to score at least 6 (agree). Each item was also assessed by an overall question ('Overall, would you support this recommendation in the Australian context?'), where available responses include 'yes', 'yes with modifications' or 'no'.

A wider panel of multidisciplinary perioperative clinicians was purposively recruited with implied consent via an invitation to participate email, which included participant information about the study. A REDCap survey link (with the AGREE-REX tool items)³¹ was embedded into the email and draft recommendations were supplied. Adaptations of items were made, based on the first round of responses before a second round of review was conducted, following the same process. Recommendations were presented and referred to, at this stage, as a pathway.

Multidisciplinary review of draft recommendations

Following adaptation of the recommendations according to the assessment of clinical credibility and implementability in the preceding stage, the draft document was formatted and refined with assistance from a professional designer. The draft incorporated:

1. Simple principles for perioperative hypothermia prevention. We organised perioperative hypothermia prevention into three principles: monitoring core temperature, active warming and minimising exposures. These represent the three main domains of hypothermia prevention, providing a guide to action that can be adapted to context (eg, including the local

environment and population needs), with the support of detailed practice recommendations where needed.

2. Practice recommendations. The second component, referred to as a pathway, provided more detailed practice recommendations with minimum requirements for perioperative hypothermia prevention accompanying, and as for the basis of, each principle.

Assessment of the quality, acceptability, applicability, comparative value and intention to follow the recommendations as a pathway was sought from multidisciplinary perioperative clinicians nationally via a Qualtrics survey. The survey comprised items from The Clinicians' Assessments of Practice Guidelines in Oncology (CAPGO) tool³² with wording adapted for perioperative hypothermia prevention (see online supplemental file 2). The CAPGO tool was originally developed and tested in an oncology setting to determine perceptions, attitudes and beliefs on guideline utility, to assess factors that influence clinician intention to use guidelines.^{32 33} The tool has since been validated in other clinical settings,^{34 35} and is an integral component of the ADAPTE toolkit.²⁸ Respondents could provide further detail if they responded 'No' or 'Unsure'. Demographic questions included professional role and location (state or territory, public or private facility).

For recruitment at this phase, perioperative clinicians were contacted via snowballing and with assistance from national professional networks, including professional college mailing lists. Eligible professions included: registered or enrolled nurses; anaesthetic allied health practitioners (anaesthetic technicians); anaesthetic medical practitioners and surgical medical practitioners. Respondents were required to be involved in perioperative care during one or more of the following phases: preadmission, preoperative, intraoperative and/or postanaesthetic care. Consent was implied via completion of the anonymous survey. We incentivised participation with a random prize draw via a separate survey link on completion.

Revision and finalisation

A subsequent round of discussion, drafting, reflection and revision of the simple principles and recommendations was undertaken by the original development team, considering the results from the national survey.

Patient and public involvement

Consumer consultation with a patient representative occurred during the finalisation stage with reimbursement for their time. Consumers will be involved in dissemination and implementation, including the development of patient information.

RESULTS

Identification and selection of evidence

After searches, 1324 records were identified. Duplicates were removed and the remainder of records screened against inclusion criteria. A total of 69 full texts were assessed for eligibility, with consensus gained on 23 papers

being deemed suitable from which to extract clinical recommendations. Reasons for the 46 excluded records are seen in the PRISMA flow diagram (figure 1). The 23 included papers included 12 guidelines,^{18 36–45} 6 evidence summaries,^{46–51} 3 standards,^{16 52 53} 1 best practice sheet⁵⁴ and 1 paper reporting an evidence-based bundle of activities for the management of perioperative hypothermia.⁵⁵ Where further duplicate guidance was found, the most recent document was included. Following appraisal with the AGREE II Rigor of Development domain, six sources were rated as high quality (scoring between 81 and 112) and considered of sufficient quality for extraction of recommendations.^{1 38 41 42 44 55} The remaining 17 evidence sources were rated as average quality, scoring between 33 and 80. Many of these documents omitted information on how they were developed. In summary, 23 articles were reviewed and appraised with recommendations extracted from the six highest quality sources.

Recommendation extraction and development of draft recommendations

After extraction of recommendations to preoperative, intraoperative and postoperative phases of care (which included combining of duplicate recommendations), a panel of multidisciplinary perioperative clinicians were invited to assess 37 recommendations against the AGREE-REX domains of clinical applicability, alignment to local values and preferences, and implementability.³¹ Ten multidisciplinary panel members consented to take part in the first round of review, following which the 37 recommendations were reduced to 25. Recommendations were either removed due to their overall score against the domains or were combined and condensed, if similar in content. For example, four items relating to the use of conductive warming were condensed to one recommendation. The mean score for most items was greater than 6 (out of a maximum score of 7). The requirement to complete incident reporting for any patient that arrived to operating theatres with a temperature less than 36°C achieved a mean score of 4.75 (SD=1.28). However, recommendations that ‘irrigation fluids should be warmed to 38–40°C’ and that ‘in adults scheduled for laparoscopic surgery, warming insufflation gases before administration is not advised until the clinical benefit is confirmed’ were included in the second round of review despite scoring <5, due to the disparities in comments made by the panel. Nine panel members participated in the second round of review for the remaining 25 items. Following this round, recommendations were condensed to 21 practice recommendations for inclusion in the draft document.

Multidisciplinary review of draft recommendations

Of 246 clinicians that responded and provided demographic details, 219 proceeded to assess the quality, acceptability, applicability, comparative value and intention to follow the recommendations via the national electronic survey. Of these, 102 (46.6%) were registered nurses, 78 (35.6%) were anaesthetists, 16 (7.3%)

Table 1 Characteristics of multidisciplinary survey respondents (n=219)

Characteristics, n (%)			
Location of work	Queensland	56 (25.6)	
	New South Wales	54 (24.7)	
	Victoria	45 (20.5)	
	Western Australia	27 (12.3)	
	South Australia	15 (6.8)	
	Tasmania	6 (2.7)	
	Australian Capital Territory	4 (1.8)	
	Northern Territory	0 (0)	
	New Zealand—North Island†	9 (4.1)	
	New Zealand—South Island†	3 (1.4)	
Private/Public	Public	152 (69.4)	
	Private	62 (28.3)	
	Not stated	5 (2.3)	
Professional College*	Australian College of Perioperative Nurses (ACORN)	83 (37.9)	
	Australian and New Zealand College of Anaesthetists (ANZCA)	77 (35.2)	
	Australian College of PeriAnaesthesia Nurses (ACPAN)	15 (6.8)	
	Royal Australasian College of Surgeons (RACS)	14 (6.4)	
	Australian Anaesthetic Allied Health Practitioners (AAAHP)	12 (5.5)	
	Other professional colleges	11 (5)	
	American Society of PeriAnesthesia Nurses (ASPAN)	3 (1.4)	
	None specified	24 (11)	
	*Some respondents were members of multiple professional colleges.		
	†ANZCA survey responses included 12 respondents from New Zealand.		

were surgeons, 12 (5.5%) were anaesthetic technicians, 3 (1.4%) were enrolled nurses and 2 individuals (0.9%) worked in management or clinical governance roles but did not provide their professional background. Table 1 outlines additional respondent characteristics.

Online supplemental file 3 provides detailed results of clinicians’ assessment of the recommendations. Overall, 201/219 (92.8%) of participants agreed the rationale for developing perioperative hypothermia prevention recommendations was clear. The pathway recommendations were assessed favourably by most participants: 87.2% (179/219) responded that they were clear, and three-quarters (n=165/219, 75%) agreed with the recommendations as stated.

Overall, most respondents (n=123/139, 88.5%) stated that they would be 'extremely' or 'somewhat likely' to use the pathway recommendations in their own practice. Over half of respondents stated that they would be 'extremely likely' to use them (n=72/139, 51.8%). In addition, 51/139 (36.7%) stated they would be 'somewhat likely'; 8/139 (5.8%) stated 'neither likely nor unlikely'; 5/139 (3.6%) stated 'somewhat unlikely' and 3/139 (2.2%) stated that they would be 'extremely unlikely' to use the recommendations.

Free text responses to questions were analysed for recurrent themes to understand where adjustments to wording to improve clarity or refinements to presentation were needed. Wording was adjusted regarding the recommendation relating to the frequency of intraoperative temperature measurement as free text responses highlighted a need for clarity. Based on clinician feedback, we shifted away from the original framing of practice recommendations as a pathway. This language was viewed as prescriptive and inconsistent with our purpose to provide principles for adaptation to context. Consumer feedback on the content of the recommendations was sought, particularly regarding patient information and how these recommendations could be ultimately applied in practice.

DISCUSSION OF SYNTHESISED GUIDANCE

Rather than adding to existing guidelines, using a structured consensus process, we present simple principles with practice recommendations for perioperative hypothermia prevention to provide direction for practice, while allowing for local adaptation and implementation.

Simple principles for perioperative hypothermia prevention

By synthesising clinical guidance to form three principles for perioperative hypothermia prevention, we acknowledge the way in which perioperative clinicians think about and work towards perioperative hypothermia prevention may matter more than focusing on the complex details of how and when to do certain activities. Systems-level improvements in care are more likely achievable by adopting principles for practice, rather than specific and rigid targets that may be unachievable.²⁶ Perioperative care delivery is influenced by combinations of factors that inhibit predictability, causing 'control by design' to be inherently resisted.²² Large-scale evaluations of perioperative practice improvement have demonstrated the challenges of achieving change across multiple levels and groups, especially when aiming for adherence to strict care pathways.^{56 57}

To overcome the fragmentation of hypothermia prevention across the perioperative period, we present three domains of prevention that can be applied across all phases of care rather than segmentation into distinct phases (eg, preoperative, perioperative or intraoperative care) (see [figure 3](#)). This also serves to reduce the complexity of guidance and addresses the widely

reported disparities in beliefs between perioperative clinicians about responsibility and ownership of hypothermia prevention.¹⁴ However, we acknowledge that clinicians will also, at times, require recommendations that provide greater detail about the how, why and when of specific activities, such as forced air warming. We provide greater detail in the practice recommendations, based on the synthesised evidence and consensus process, to accompany each principle ([figure 4](#)).

Monitoring core temperature

Monitoring core temperature is a central component of perioperative hypothermia guidelines,^{1 42 44} both as a mechanism to observe actual temperature at any time and over time, but also vital when warming interventions are used to measure efficacy and potential overheating. Monitoring core temperature should occur consistently throughout the surgical pathway: to this end, continuous temperature monitoring is preferable. Our consensus process synthesised recommendations that suggested continuous,⁴⁵ 15 minutely^{1 44} and 30 minutely monitoring.¹ Distinct timepoints are also identified in existing guidance,^{1 44 55} often at transition points during the perioperative pathway. Our synthesised recommendations to accompany the overall simple principle are presented in [figure 4](#).

Survey feedback suggested that clinicians desire recommendations on what monitoring devices should be used. Frustration with device accuracy was expressed. While some guideline documents offer scant information regarding device selection, these statements are often vague. Practical issues with temperature device selection are well known: the most accurate devices are the most invasive and not appropriate for use in most surgeries, and the most widely used, available and accessible non-invasive devices (in particular, infrared ear devices)^{2 13} are unreliable and inaccurate.⁵⁸ It is well known that sites providing true core temperature measurement are the most invasive: the pulmonary artery, distal oesophagus, nasopharynx and tympanic membrane.⁵⁹ Near-core temperature estimates can be obtained at oral and axillary sites, with care and in the appropriate circumstances.⁵⁹ We have stopped short of providing recommendations for device selection, which depends on many factors including local availability, surgical procedure and monitoring site accessibility.⁴² Important future work lies in developing decision-support tools for device selection, based on accuracy and practicality of core and near-core temperature monitoring. This would complement the perioperative hypothermia prevention principles.

Warming actively

Active warming throughout the perioperative period is a core component of perioperative hypothermia guidelines.^{1 42 44} Forced air warming is the recommended mode of active warming, although some guidelines and recommendations provide additional recommendations on other modalities, such as conductive warming.^{42 44}

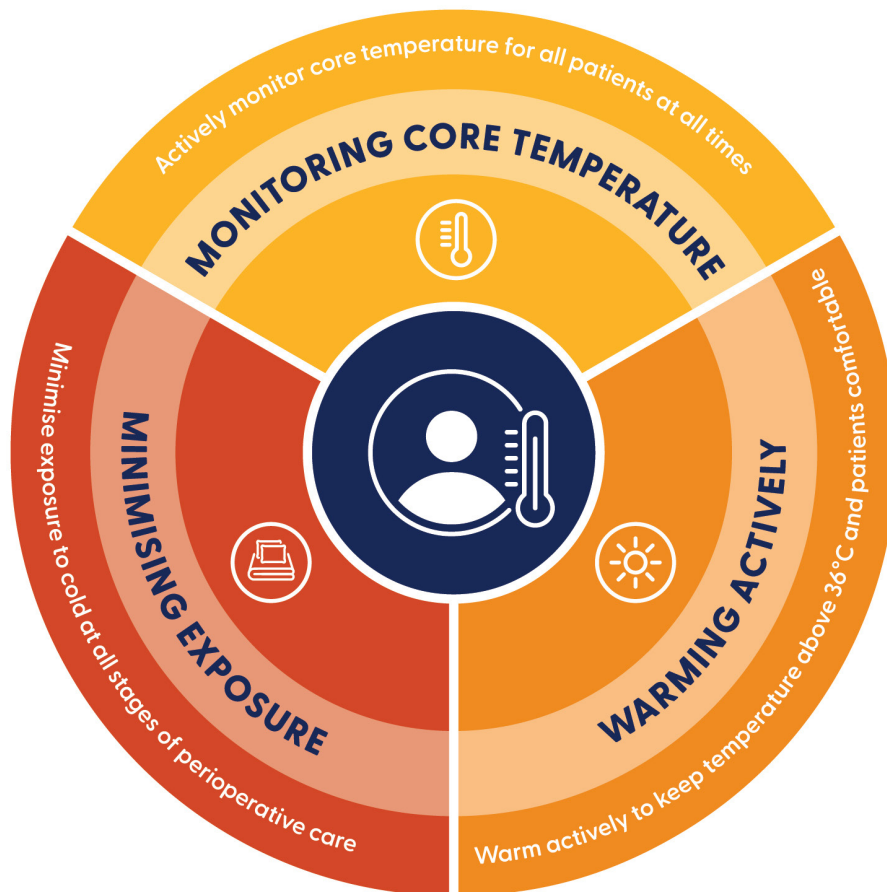


Figure 3 Simple principles for perioperative hypothermia prevention.

MONITORING CORE TEMPERATURE 	WARMING ACTIVELY 	MINIMISING EXPOSURE 
<p>Core temperature is preferably measured continuously when possible, and always monitored when active warming is used. At a minimum, timepoints for monitoring are as follows:</p> <p>Preoperatively: Within one hour prior to induction, or transfer to the operating theatre.^{1,2}</p> <p>Before induction: Prior to anaesthesia induction.¹</p> <p>Intraoperatively: At intervals no greater than 30 minutes.¹</p> <p>In PACU: On arrival,^{1,2} at intervals no greater than 30 minutes and upon discharge.</p>	<p>Forced air warming is the recommended active warming intervention.¹ Active warming should be used to keep patient's body temperature above 36°C, and to keep patients comfortable. At a minimum, active warming should be used as follows:</p> <p>Preoperatively: At least 30 minutes before anaesthesia induction unless this will delay emergency surgery.</p> <p>Intraoperatively: For all patients scheduled to receive general or neuraxial anaesthesia of 30 minutes or greater duration.³ Additional recommended active warming includes warm intravenous (IV) fluids for all patients receiving infusions of >500mls; ⁶ irrigation fluids warmed to 38–40°C.^{1,4}</p> <p>In PACU: Continue forced air warming as needed to keep body temperature above 36°C and patients comfortably warm.¹</p>	<p>Exposure to cold should be minimised at all stages of perioperative care, by always keeping patients covered where possible. If patients are exposed intraoperatively, ambient temperature should be maintained to at least 21°C.^{1,5}</p> <p>Patient Information: Patients and carers should be provided with information on why they need to stay warm, that the operating theatre environment is colder than home, and the need to bring additional clothing.¹ Staff should empower patients by encouraging and providing opportunities to inform staff if they feel cold during the perioperative period.¹</p> <p>Ambient Temperature: If patients are exposed, the operating room should be maintained at a temperature of at least 21°C.^{1,5}</p> <p>Exposure: In addition to active warming, the largest possible area of the body (not actively warmed) should be covered.</p>

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Figure 4 Practice recommendations for perioperative hypothermia prevention. PACU, post anaesthetic care unit.



Intravenous fluid warming is included in guidelines, not as a replacement for, but as an additional intervention for use with forced air warming^{1 38 42 44}: the volume of administered fluids influences decision-making regarding efficacy, as does the method of fluid warming. Active warming (using forced air) is preferably commenced preoperatively^{1 41 42} and continued intraoperatively,⁴¹ switching the emphasis to pre-warming rather than re-warming. The clinical rationale for prewarming is based on increasing peripheral heat content to decrease heat loss through the core-periphery heat gradient during anaesthesia. Specific recommendations on required duration of preoperative warming vary from short periods of 10 min to longer periods of 60 min or longer.⁶⁰ Our consensus process considered shorter periods of preoperative warming (from 10 to 30 min pre-induction)⁴⁴ which may be easier to enact in practice than longer periods (over 30 min). Our final synthesised guidance suggests preoperative warming is commenced if temperature is less than 36°C¹ and at least 30 min before anaesthesia induction unless this will delay emergency surgery.¹ Evidence to guide target core temperature during active warming is lacking and more aggressive warming targeting >36°C may not be superior to current guidance.⁶¹ A recent large-scale randomised controlled trial found no clear benefit of preoperative and intraoperative forced air warming targeting at least 37.0°C compared with routine care (with forced air warming initiated to maintain at least 35.5°C) for myocardial injury, non-fatal cardiac arrest or mortality.⁶¹ We have synthesised practice recommendations as detailed in [figure 4](#).

Minimising exposure

Minimising exposure to the cooler environment promotes a proactive approach to reducing heat loss including patients and carer involvement, as well as the entire perioperative team. Some guidelines recommend discussing the potential for heat loss during surgery and the need to keep warm and to bring additional clothing with patients and carers.¹ Minimising exposure to the cooler environment is an approach to care that can be continued throughout all perioperative phases: intraoperatively, patients should only be exposed when and as necessary. Maintenance of ambient temperature to at least 21°C is recommended.^{1 38 44} Nonetheless, we acknowledge that maintenance of intraoperative ambient temperature is contested by surgical teams, as noted during our consensus process. However, minimising exposure and paying attention to ambient temperature—particularly if exposure is required—applies to all phases of perioperative care. Our synthesised practice recommendations are presented in [figure 4](#).

Research and policy implications

The significance of our work is the development of a knowledge product that has been contextualised for implementation and is ready for adoption and adaptation in Australian practice.²⁷ What is also new is how we have

packaged the consensus-based evidence using simple principles, and how this functions to guide implementation in practice.

Our application of a consensus-based approach to knowledge creation demonstrates how practice guidelines can be distilled into a set of principles and recommendations that are easily grasped for implementation. The same process could be applied to multiple other areas where there is a proliferation of guidance, yet no clear impact on practice. Simple principles and recommendations that provide minimum specifications allow for creative adaptation and innovation in areas where complexity flourishes.⁶²

The effectiveness and impact of the principles and recommendations on patient outcomes remain to be tested. Our planned implementation trial will evaluate the use of the principles and recommendations, integrating local adaptation and team-based strategies to implement practice change for perioperative hypothermia prevention. Further refinement may occur as the evidence base grows and after implementation and evaluation of the principles and recommendations in practice.

Strengths and limitations

We used a consensus-based approach, using the ADAPTE²⁸ process, to develop principles and recommendations for perioperative hypothermia prevention. To address the complexity of perioperative hypothermia prevention, we present simple principles underpinned by practice recommendations to assist with adaptation and implementation. The practice recommendations incorporate minimum specifications which allow for creative adaptation and innovation while providing direction and boundaries.⁶⁰ A multidisciplinary team representing nursing, anaesthesia and surgery contributed either as members of the core investigatory team, panel or wider network of clinicians to evaluate the recommendations. Clinicians electing to participate may place higher importance on perioperative hypothermia prevention than clinicians not participating, however, this is a strength in the context of the consensus process which requires involvement of team members with clinical expertise on the topic. In addition, survey dissemination through ANZCA also reached members in New Zealand, although only 12 respondents from New Zealand participated.

CONCLUSION

Our recommendations emphasise a proactive approach to perioperative hypothermia prevention and management. The simple principles and practice recommendations are intended for use in conjunction with clinical judgement and with knowledge of the local context. This work is an important conceptual stage in knowledge translation for perioperative hypothermia prevention and requires further testing in an implementation trial to determine the impact on patient care and outcomes.

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Acknowledgements The following clinicians took part in the multidisciplinary panel and agreed to be acknowledged: Ruth Melville; Michelle Hibbersen; Penny Heidke; Simon Maffey; Nicolas Fernandes; Bipphy Kath; Jess Bendeich and Sasha Rademakers. In addition, we acknowledge the support of the following researchers and clinicians: Clint Douglas for advice and feedback regarding the writing of the draft and revisions, Ken Ho for support with survey dissemination, and the support of Dale Trevor, consumer representative. We wish to acknowledge the support of the following professional colleges in disseminating the surveys: Australian College of Perioperative Nurses (ACORN); Australia and New Zealand College of Anaesthetists (ANZCA); Australian College of Perianaesthesia Nurses (ACPAN); Australian Anaesthetic Allied Health Practitioners (AAHP), Neurosurgical Society of Australasia (NSA); Urological Society of Australia and New Zealand (USANZ); Royal Australasian College of Surgeons Western Australia (RACS WA) and Queensland Surgical Advisory Committee (QSAC).

Contributors This study was conceptualised by JM and JD. JM and JD contributed to methodology. JM and M-AR contributed to validation. JM, JD and M-AR contributed to formal analysis. M-AR conducted all searches and contributed to investigation. JM, JD, DS, FMW, NR and M-AR conducted appraisal of sources and recommendations. M-AR, JM and JD extracted and mapped recommendations. M-AR and JM contributed to data curation. JM contributed to writing – original draft. JM, M-AR, JD, FMW, DS and NR contributed to visualisation. JM and M-AR contributed to project administration. JM and JD contributed to funding acquisition. Writing – review and editing: final drafting of the manuscript was completed by JM, with assistance of M-AR and final review by JD, FMW, DS and NR. All coauthors approved the final manuscript for submission. JM: guarantor of work.

Funding This work was supported by 3M in the form of funding support provided to Queensland University of Technology (QUT): grant number N/A. However, the funders had no role in the design, conduct or analysis of the study, nor received the final draft prior to submission for publication.

Competing interests JM has received educational consultancies from 3M, and her employer has received research support in the form of funding for work unrelated to this project. JM co-authored one of the documents reviewed during this project, but this document was not used to formulate recommendations. JD has received honorariums from 3M for educational consultancies, and his employer has received grants from 3M for work unrelated to this project. JD co-authored one of the documents included during this project but was not involved with the appraisal of this document.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by Queensland University of Technology's Human Research Ethics Committee (HREC, reference: LR 1021 HE21). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. Data related to surveys are not available due to the requirements of ethical approval. However, data related to other phases of this study are available upon reasonable request.

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